meals for their families. You and the retailers can nelpful along that line.

Retailers do not have time, among all their duties, to work out special display ideas with selling signs, special advertising copy for newspaper or circular advertising, or special merchandising features for your various products—but you have "experts" who could develop these ideas and pass them along to the retailers. If you do not have these experts—at least you can urge retailers to use materials available to them so that they will do a better "all around" job in the store.

May I point out one other thing, too, and that is the fact that we are all in the business to make money and we need not be ashamed of that fact. We certainly are not interested in profiteering, but we are all entitled to a reasonable return on our investment and a reasonable wage for our work. This applies to you as well as it does to the laboring man, and certainly it applies to the retailer who has an investment in a business and who is charged with the duty of bringing good, healthful foods to his many customers. Therefore, you need not conclude that the best way to encourage the sale of your merchandise is to urge retailers to cut the price or sell it at a low margin. That does not work out.

I am optimistic about the future of the food industry for a number of reasons including those mentioned early—namely the fact that there are more and more people in this country, plus the fact that more and more of our people are interested in better quality food, more appetizing meals, and a greater variety.

There is another reason why I am optimistic about the future of this industry—and now I am speaking strictly of the retail food industry—and that is the fact that we have o many specific examples of the real opportunities there .re in the field. Take a look at the young man who came to this country in 1921 with $14.00 which his mother sewed in his underwear. He had odd jobs until he went into the push cart vegetable business in 1929. In 1930 he and his brother went into a small retail food store in New York City and at the end of their first year of business in 1931 they had recorded a total volume of $48,000. In 1948 their business accounted for a total volume of $1,860,000 and in 1949 they are aiming for $2½ million dollars. That is Patsy D'Agostino, who was formerly the president of our association and who many of you know. There is another example in Des Moines of a young man by the name of W. T. Dahl, who opened a retail food store a few years ago with $300—most of which was borrowed. He got credit from his suppliers and since 1930 he has shown phenomenal growth until he is now doing more than $2,000,000 worth of volume. Down in Joplin, Missouri, there is a retailer by the name of Nelson who had worked for 20 years (except for three days) with a chain. In 1947 he opened his store and at the end of the first year in business had recorded a total volume of $60,000, in 1948 the volume was up to $200,000 and his aim for 1949 is a quarter of a million dollars. None of these retailers just sat idly by and hoped business would come to them—but they did the best job they knew how with all the facilities they could possibly locate anywhere.

The National Association of Retail Grocers is doing everything they can possibly do for these members in the way of helpful suggestions in the operation of their busin as is evidenced by the examples here—and the flavorin xtract manufacturers can assist, too, if they will follow ome of the suggestions made in the early part of this talk the manufacture and packaging of their commodities,—then render every possible assistance to retailers in d a better merchandising and selling job.

It has been a pleasure to be with you, and I hope you have gained something worthwhile from these brief remarks.

About half way through the morning session, Professor Hutchins asked Mr. Pegler, what he thought on the subject and Mr. Pegler said, "I'm sorry, Doctor, I fell off the sled when you went around the first turn." And that is what happened to me.

Seriously, gentlemen, I don't know why you gave me the title of "Let's Look Ahead." From the part of your program that I have heard and the other part I have looked at, I conclude that that is the theme of your program—You are looking ahead. I felt that way earlier when your program chairman invited me to come and talk with you.

President Beggs: Thank you, Mrs. Kiefer for your very fine remarks. I am sure that if we all followed your suggestions, we wouldn't be worrying about hard times.

Our next speaker is R. Henry Morris, III, who, has been responsible for the commercial development of different research accomplishments.

Mr. Morris has brought samples to illustrate his talk, a sample of apple essence preserve and candy which is here on the desk and we will pass it around as far as it will go.

I have pleasure in introducing Mr. Henry Morris, III. (Applause)

PRODUCTION AND UTILIZATION OF VOLATILE FRUIT CONCENTRATE

R. Henry Morris, 3rd
Special Assistant to Director,
Eastern Regional Research Laboratory[1]
Philadelphia, Pennsylvania

Events which led to discovery of the method for recovery of volatile fruit concentrates are described, as well as improvements made in the process. Some of the problems that have arisen in connection with its industrial application are discussed. These include: nomenclature, commercial-scale operation factors, application to commercial products, composition, effect of apple varieties on quality, application of process to other fruits, alcohol content, development of method for higher concentrations, and present commercial status. Volatile concentrates have been produced from the following products: apples, grapes, peaches, cherries, strawberries, pineapples, apricots, blackberries, Damson plums, black raspberries, blueberries, oranges, rhubarb, Youngberries, quinces, cranberries, tomatoes and maple syrup. The first eight have been produced commercially. Approximately 50 units have been installed. One company has a capacity for processing 5,000,000 gallons of apple juice annually.

For many years, scientists have sought a way to impart to fruit products all the desirable natural flavor of the fresh fruit. One of the most elusive characteristics of fresh fruit is its delicious and enticing fragrance. This quality may be lost or so altered by the processing operation that only a mediocre product is obtained. Attempts to correct this situation have generally been directed either toward capturing these volatile constituents for return later to the finished product or adding a synthetic flavor. In either case, it has been extremely difficult to impart an aroma which would duplicate that of fresh fruit.

Real progress in this direction has been made as a result of the discovery (U. S. Public Service Patent No. 2,457,315)[2]

---

[1] One of the Laboratories of the Bureau of Agriculture and Industrial Chemistry, Agriculture Research Administration, United States Department of Agriculture.

[2] Milleville, H. P., "Volatile Flavor Recovery Process," U. S. Patent No. 2,457,315, issued December 28, 1948.

of a process for recovery and concentration of the natural volatile flavor constituents of fruit juices. The method as applied to apple juice is described in our publication AIC-63[3].

This discovery was the direct result of our efforts to increase the utilization of apples by improving the natural flavor of apple products. To accomplish this required the recovery of the volatile constituents normally lost in processing, and their subsequent return to the finished product.

Our initial objective was to produce a full-flavored, concentrated apple juice, which would yield a beverage comparable in flavor to the fresh juice. It was apparent that this would entail the recovery of the volatile flavoring constituents in unaltered form for subsequent return to the concentrated juice. Therefore, a study was made of the conventional method of condensing the first 10% of the vapors from the vacuum evaporation of apple juice, returning this condensate to the evaporator and again collecting the condensate from the first 10% of the vapors. This condensate, which represented 1% of the volume of the original juice, was then returned to the concentrated juice. It was found that the mixture, when reconstituted with water was unsatisfactory, as it lacked some of the "top notes," and hence did not have the true aroma and flavor of the original fresh apple juice.

A chemical engineer was then assigned the problem of finding an improved method for capturing these volatile flavoring ingredients. He developed a process for the recovery and concentration of the volatile components of the fresh juice in unaltered form. This process gave a 150-fold volatile apple concentrate. One gallon of the concentrate contained the volatile flavoring constituents from 150 gallons of fresh juice, which is almost equivalent to the juice from a ton of apples. A ton yields approximately 160 gallons of juice. When returned to the concentrated juice, this product gave an excellent full-flavored concentrate, which on reconstruction with water, yielded a delicious apple beverage indistinguishable in natural fragrance and flavor from fresh juice.

The original process consisted in the rapid passage of the fresh juice, after screening, through a narrow steam-jacketed tube in which it was heated under pressure to 320°F. in 2 to 3 seconds and then released in an atmospheric pressure flash chamber. This resulted in approximately 10% vaporization. After the vapor was separated from the liquid, it was concentrated further by passing it through a packed fractionating column, and then through a total condenser. The 150-fold volatile apple concentrate was withdrawn from the condensate receiver at a volume rate of 1/150th of that of the fresh juice feed rate. The remainder of the condensate was refluxed to the column at a temperature of 180°F. In order to prevent damage to the flavor of the stripped juice while awaiting further processing, it was cooled by passing it through a jacketed line.

Although this method gave an excellent volatile concentrate, the process was not satisfactory for commercial operation because fouling of the superheater surface reduced the heat transfer coefficient to 25% in 20 minutes. This condition was corrected by substituting a rapid evaporator for the superheater. The evaporator was a 16½ foot jacketed tube of 0.62 inch inside diameter. In this improved set-up 10 percent of the juice was vaporized by passing it through the tube in 10 to 15 seconds and heating it to approximately 218°F. From the evaporator, the mixture passed to the separator. As in the previous method, the vapor then passed to the fractionating column. The volatile concentrate was just as good as that produced by the previous method. The improved method had the dual advantage of

3"Recovery and Utilization of Natural Apple Flavors," by H. E. Milleville and R. K. Eskew, AIC-63, Bureau of Agriculture and Industrial Chemistry, September 1944.

reducing the fouling to the minimum and requiring a steam sure of only about 30 pounds per square inch, as com- ed with approximately 120 pounds per square inch for he superheater. This unit, which had a capacity of 50 gallons of juice per hour, was described in a mimeograph supplement issued in April 1945[4].

Samples of the volatile apple concentrate and full-flavored concentrated apple juice were then prepared for evaluation by industry. Equipped with these samples, we discussed the development with representatives of industry, trade publications and associations who might be in a position to make use of it. Their suggestions and criticisms proved to be of the utmost value to us as a guide for further research.

Arrangements were then made for industrial evaluation tests. Here it was necessary to cooperate closely both with prospective manufacturers and with users of the product.

I should like to tell you about some of the developments that have resulted from these industrial activities. I shall also mention a few of our problems.

Nomenclature

Originally the product was called "natural apple flavor", but since this did not indicate that it was volatile and concentrated, the name was changed to "apple essence." This terminology resulted in considerable confusion because of the implication that the product was the result of an alcoholic extraction process. To clarify the situation, it was suggested[5] that the term, "volatile apple concentrate" be adopted in place of "apple essence." The term "volatile concentrate" can be applied to products obtained in a similar way from other fruits.

Commercial-Scale Operation

Industry showed a keen interest in the new process, and immediately asked for detailed information on equipment and on processing factors. To meet this need, a flow sheet of the process was drafted which showed equipment and processing data for a unit with a capacity for processing 100 gallons of apple juice per hour[6]. I have attached a copy of the chart to this paper.

Demonstration of Flavor Value

To test the new apple product as a flavor for various foods, and to demonstrate its application, the Laboratory prepared table sirup, jelly and candy in which it was used as a flavor.

Table Sirup: This was one of the first applications considered for volatile apple concentrate. Sirup was prepared with bland apple sirup[7] as a base, but this left a bitter "after-taste," which we believed was caused by calcium malate. Ion-exchange treatment reduced the calcium content and corrected this difficulty. The sirup was then free of the bitter "after-taste" but too expensive to use in competition with other sugar sirups. Furthermore, it lacked sufficient flavor strength to be used as a flavor for cheap sugar sirup bases. Eventually an acceptable table sirup was prepared by the following formula.

⅛ full-flavored concentrated apple juice
⅞ invert sirup
⅞ corn sirup

Jelly: We then used the volatile apple concentrate in jelly. We selected jelly not only to show the value of the flavor for this purpose but also to work out a method of incorporating a volatile product in heated material with the minimum of loss. We found that three precautionary measures would prevent serious loss—a slow set pectin, addition of the volatile apple concentrate with a portion of the sugar sirup, and addition of the acid as late in the process as possible.

The following method was used for preparing the full-flavored apple jelly:

1. Weigh 330 grams of depectinized concentrated (78.3° Brix) apple juice.
2. Add 1260 grams of water.
3. Agitate the mixture and heat to approximately 30°C.
4. After adding 9.72 grams of pectin (Certo E2745—250 grade) and 100 grams of sugar, bring mixture to a boil.
5. Add 2500 grams of sugar, and remove scum.
6. Add 90 ml. of citric acid solution (21%) and 14 ml. of volatile apple concentrate (140 fold), and agitate the mixture.
7. Pour mixture into sterilized containers and seal immediately.

In this formula, 0.33% of volatile apple concentrate is used.

Attention is called to the fact that the use of volatile apple concentrate in apple jelly, preserves or jams is in violation of the Federal Food, Drug and Cosmetic Act, because Standards of Identity have been set up for these products. Such Standards of Identity do not provide for the addition of volatile apple concentrate.

Candy: A research study[8] was conducted at the Laboratory on the preparation of an apple-flavored candy. This

---

4AIC-63, Sup. 1, April 1945.

5"Present Status of the Manufacture and Use of Volatile Fruit Concentrates," by H. P. Milleville, Fruit Products Journal & American Manufacturer, December 1947, Vol. 27, No. 4, pp. 99-102, 121.

6"Recovery of Volatile Apple Flavors in Essence Form," by H. P. Milleville and R. K. Eskew, Western Canner & Packer, October 1946, p. 51-54.

land Apple Sirup," by H. H. Mottern and R. H. Morris, 3rd, AIC-37, Bureau of Agriculture and Industrial Chemistry, January 1944.

8"Research in New Apple Flavors," by F. B. Talley, The Manufacturing Confectioner, December 1948, Vol. XXVIII, No. 12, p. 27-28.

study included the following types of candy: Pectin gum, starch gum, fondant, nougat, brittle, marshmallow, caramel, fudge and hard candy. The most popular type was the pectin gum candy. It has met with an enthusiastic reception.

The following formula and method were used for this candy:

10 grams of slow setting pectin (190 grade apple pectin)
400 ml. of water
342 grams of sugar
342 grams of corn sirup
2 grams of sodium citrate
4 grams of citric acid
20 ml. of volatile apple concentrate (150-fold)
60 grams of concentrated depectinized apple juice (78° Brix)

1. Bring the water to a boil.
2. Mix the pectin with approximately ¼ of the sugar and slowly add it to the boiling water with constant stirring.
3. Dissolve the sodium citrate in a small amount of water and add it to the mixture.
4. Add the corn sirup and the remainder of the sugar.
5. Heat to 227-228° F. with stirring to prevent scorching.
6. After removing from heat, add the volatile apple concentrate to the batch with rapid stirring to insure thorough blending.

In this formula 1.7% of volatile apple concentrate is required to give a satisfactory apple flavor to the candy.

Composition

The volatile apple concentrate did not appreciably change in the strength or character of its fragrance even when kept for several years at room temperature. However, when it was mixed with concentrated juice or jelly, there was a significant loss in strength in a few months, in spite of the fact that the product was hermetically sealed. Also, when it was used in milk or in ice cream, there was a noticeable decrease in fragrance. When these observations were brought to the attention of some members of your industry, they suggested that information on the constituents of volatile apple concentrate was necessary before methods could be developed for its stabilization in different products. Our Laboratory undertook this investigation.

The following compounds were identified in 150-fold volatile apple concentrate from a 50-50 mixture of McIntosh and Stayman Winesap apples, and the approximate concentration of each was determined.[9]

	Parts per million
Acetaldehyde	260
Acetone	8
n-Caproaldehyde	90
2-Hexenal	64
Furfural	1
Methanol	200
Ethanol	5380
n-Propanol	75
Isopropanol	23
n-Butanol	780
Isobutanol	20
d-2-methylbutanol	270
n-Hexanol	240
Ethyl n-butyrate	70
Ethyl n-caproate	40
Other ester components:	
Alcohols: Methyl, ethyl) isopropyl, n-butyl) (possibly n-hexyl)	26
Acids: Formic, acetic, propionic, n-butyric, n-caproic)	
Total	7547

A total of 7547 parts per million in the 150-fold voatile apple concentrate would be equivalent to 50 parts per million in the original juice—an extremely low concentration. The alcohols and acids listed under "Other ester components" were all isolated from esters, but the esters were present in mixture in small quantity, so it cannot be definitely stated which alcohol was coupled with which acid to make the ester.

These constituents may be grouped as follows: alcohols, 92%; aldehydes and ketones, 6%; and esters, 2%. Of course, this analysis refers only to one specific sample. Although it would vary somewhat according to the variety and maturity of the apples, it should prove useful as a guide.

Apple Varieties

Commercial users stressed the need for definite information on volatile flavors from the different varieties of apples so that they would be able to specify the blend most suitable for their products and standardize their flavors.

To answer these questions, the volatile flavors from nine varieties of apples[10] were recovered and concentrated to 150-fold under essentially the same condition. The volatile concentrates were then used in pectin gum candy, jelly, and concentrated apple juice (subsequently reconstituted with water for taste tests), as they could be compared more satisfactorily in these potentially commercial products than in their original form. The widest variation in flavor was in candy and the least in jelly. The standard, a blend of Stayman and McIntosh, was rated better in all products than any individual variety. Some of these volatile con-

[9] "Composition of a Volatile Apple Concentrate," by J. W. White, Jr., (In Press) Journal of American Chemical Society.

[10] "Comparison of thee Essences from Nine Varieties of Apples," by E. L. Griffin, F. B. Talley and M. E. Heller, Fruit Products Journal & American Food Manufacturer, September 1947, Vol. 27, No. 1, Pages 4-5, 27.

centrates made a decided improvement in all products; the most desirable flavors were obtained from the McIntosh, Delicious, Grimes Golden, Stayman, and Jonathan. Golden Delicious and Baldwin were intermediate, and the least desirable were the Northern Spy and Rhode Island Greening.

Other Fruits

After the successful development of a commercial process for recovery of volatile apple concentrate and demonstration of its application, there was an urgent demand by industry for the application of this technique to other fruits. As oranges were of particular interest, preliminary tests were made at our Laboratory. However, because of the lack of suitable processing facilities for citrus fruit and the perishable nature of orange juice, this study was transferred to the U.S. Citrus Products Station at Winter Haven, Florida, where commercial type juice was available. Exploratory runs were made there with our pilot-plant equipment. Certain modifications of the process and equipment were found necessary because of the nature of orange juice, especially its oil content. This problem is still under investigation.

Aside from oranges, our work on other fruits has been limited mainly to grapes and strawberries. For grapes a 20-25% vaporization is required. As the vaporization factor is different for each fruit, it must be determined for the particular fruit to be processed. We have not yet published the results of these studies but hope to be able to report on Concord grapes within the next few months.

Volatile concentrates have been produced by various organizations from the following products—apples, grapes, peaches, cherries, blueberries, strawberries, pineapples, apricots, oranges, rhubarb, Youngberries, Damson plums, black raspberries, quinces, cranberries, tomatoes and maple sirup. In processing cranberries and certain other fruits, however, serious difficulty is encountered because of the highly viscous nature of the juice, which makes it almost impossible to obtain a satisfactory volatile concentrate by the method used for apple juice.

To facilitate studies on other fruits, we have designed and built a portable recovery unit with a capacity of ten gallons of juice per hour. This unit has been taken to various places for tests on fruits. Plans of the unit are available.

Use of Stripped Juice

Unless the volatile flavors are subsequently to be returned to the residual juice to produce a full-flavored concentrate, the question arises, How best utilize the stripped juice? In processing apples and grapes, this problem is not serious. The stripped apple juice can be evaporated to produce a bland sirup for use as a humectant or to make a concentrated juice, which is extensively employed in the manufacture of jellies. It may be useful in the manufacture of vinegar, wine and brandy. The stripped grape juice has been concentrated and used in the manufacture of wine. With other fruits, this problem is more difficult. Some manufacturers are evaluating the possibility of concentrating this stripped juice and utilizing it in fruit spreads, candy, pies and ice cream products.

Alcohol Content

The alcohol (ethyl) content of a volatile fruit concentrate is of particular significance, as these flavors are subject to the Internal Revenue tax of $9.00 per gallon, if they contain 0.5% or more of alcohol. Under laboratory conditions, we have been able to produce a 150-fold product with an alcohol content under this limit, but a delay in processing or the presence of yeasts in unsound fruit may cause the alcohol concentrate to be considerably higher. It

takes only 0.004% of alcohol in the original juice to give a 150-fold volatile concentrate with 0.6% alcohol, which is taxable. Commercial samples analyzed in our Laboratory varied widely in alcohol content. Some were as high as 12%. Certain fruits, such as grapes, are more likely to ferment than others—for example, apples. Also, concentration of the volatile concentrate affects its alcohol content.

We are continuing our efforts to produce volatile fruit concentrates with an alcohol content below 0.5%. In one experiment, it was found that evaporation of only 3% of the juice yielded a satisfactory 150-fold (by volume) product with 0.15% of ethyl alcohol, as compared with 0.4 and 0.5% of alcohol with the usual 8% to 10% evaporation.

There may be a loss of volatile flavors when operating below the 8% evaporation rate, but this loss may be justified by the reduction in alcohol content. We are now evaluating the factors responsible for the presence of alcohol in the juice and the quantitative relation of this alcohol to that in the volatile concentrate.

The volatile fruit concentrates produced in Canada for sale in this country are exempt from this tax, provided they have been denatured with 25% of sugar or six ounces of tartaric or citric acid per U. S. gallon. We have been informed, however, that the addition of these acids may seriously affect the flavor.

Full information on the production and sale of products subject to regulation by the Bureau of Internal Revenue may be obtained by writing to Mr. Carrol E. Mealey, Deputy Commissioner, Alcohol Tax Unit, Treasury Department, Washington, D. C.

Higher Concentration

Although a 150-fold concentration is sufficient for use in beverages and most food products, certain dried foods and industrial products require a much more highly concentrated flavor. Also, because of the alcohol tax, it is desirable have a more highly concentrated product to reduce the tax per unit of flavor. To fulfil these needs, the Laboratory produced an 800-fold volatile apple concentrate, using the equipment described in the October 1946 issue of "Western Canner and Packer"[5], and immersing the vent gas scrubbing tower and its precoolers in an ice bath.

Present Commercial Status

In the three and a half years since the installation of the first commercial volatile fruit concentrate unit—in October 1945—approximately 50 units have been installed, most of them by members of your industry. One plant has a capacity for processing 5,000,000 gallons of apple juice (about 1,250,000 bushels of apples), which yields 35,000 gallons of volatile apple concentrate. Another apple-processing plant has installed three units. Since the commercial production of volatile apple concentrate started, its price has dropped from $15.00 to $5.00 per gallon, exclusive of tax.

Volatile concentrates have been produced commercially from grapes, peaches, cherries, blackberries, strawberries pineapples and apricots. At present, the commercial production of these products is almost at a standstill, awaiting clarification of the tax situation.

Industry is exploring the possibility of recovering the volatile flavors from fruit byproducts, such as grape skins apple peels and pineapple wastes, as the flavor is largely concentrated near the skin. Some have reported that their preliminary results have been successful. Others are investigating a modification of the process that will make it possible to recover volatile fruit concentrates from the condensed vapors given off during the manufacture of preserves and other products. Also, the possibility of combining certain features of the volatile fruit concentrat

process with the alcoholic extract process is now being studied by some members of your industry.

One of the largest maple processors in the world has reported the recovery of a volatile maple concentrate. Another concern has produced volatile fruit concentrate of 1700 fold.

Now that some of the accomplishments of commercial production of volatile fruit concentrates have been covered, I shall point out a few of the markets established for these products:

Flavoring extracts—Volatile fruit concentrates are used to supply certain natural "top notes" difficult to obtain by the use of synthetic flavors.

Beverages—Volatile apple concentrate is used either with or without the corresponding concentrated juice.

Ice cream products—Volatile fruit concentrates have been found to contribute greatly to the flavor of ices—but if the same quantity of volatile concentrate is used in ice cream, its flavor is hardly noticeable. A good product can be obtained, however, if the volatile flavors are incorporated in ribbons of ice running through a vanilla ice cream.

Candy—Volatile apple concentrate is used to flavor pectin gum type candy.

Pharmaceuticals—Volatile fruit concentrates are used to improve or mask disagreeable tasting medicinal products.

In addition to the above, successful results have been reported on the use of volatile apple concentrates to flavor table sirups, apple sauce and honey.

From this discussion, you can see that the development of volatile fruit concentrate has had its full share of "growing pains." Although many problems are still awaiting solution, a definite progress has been made in the use of this development by industry.

President Beggs: Thank you, Mr. Morris, for that very interesting address.

The next speaker on our program is Lt. Colonel Clyde C. Simkus, Quartermaster, Industrial Mobilization Planning Office at Chicago.

QUARTERMASTER INDUSTRIAL MOBILIZATION

Lt. Colonel Clyde C. Simkis

Mr. Chairman, ladies and gentlemen:

As we study the characteristics of modern war, we realize that the protection of our country is no longer predominantly a military problem. Our ability to defend ourselves will depend on properly trained manpower immediately and effectively supported by enormous quantities of superior weapons, equipment and supplies. The National Military Establishment is responsible for the trained manpower. American industry must assume the principal responsibility for the essential and enormous quantities of superior weapons, equipment and supplies.

American business cannot delay active acceptance of this responsibility until our country is attacked—unless industry is prepared in advance, we may well lose the next war.

We fought World War I with equipment supplied largely by our Allies. It would have been two years after the declaration of war before we ourselves could have equipped and sent overseas an effective armed force—the war was over by that time.

Although American industry began converting to war production many months before Pearl Harbor, it was at least a year later before we had adequate supplies and equipment